



**Bi-directional 48V-12V Non-Isolated  
DC/DC Converter**

**Model: TCDUB2000202**

**Name: 2kW Bi-directional DC/DC Converter**

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# 1 Summary

## 1.1 Abstract

This document mainly defines the specifications and performance parameters of 48V/12V bidirectional DC/DC converters for automobiles.

## 1.2 Terminology

No.	Terminology or abbreviations	Description
1	DC/DC	DC/DC ( DC/DC Converter )
2	CAN	CAN ( Controller Area Network )
3	VCU	( Vehicle Control Unit )
4	ASIL	( Automotive Safety Integrity Level )
5	Io	DC/DC output current
6	IN	DC/DC nominal current
7	BMS	( Battery Management System )

## 1.3 Scope of application

This document is a technical specification for the 48V/12V bidirectional DC/DC converter product for automobiles, applicable to 48V/12V dual battery automotive systems.

## 1.4 Introduction to the main functions of the system

### 1.4.1 DC/DC Conversion function

The DC/DC converter receives control signals from the vehicle controller to achieve bidirectional conversion of 48V/12V batteries in the car, meeting the charging and discharging requirements and load requirements of 48V and 12V batteries, while also providing feedback on its own status and load status.

### 1.4.2 CAN communication function

DC/DC controls the output voltage and current through the CAN bus, and communicates with BMS and VCU through CAN communication to exchange information and provide feedback on the working status.

### 1.4.3 Self diagnosis and multiple protection functions

Equipped with self diagnosis, input/output overvoltage/undervoltage protection, short circuit protection, hardware fault protection, over temperature protection, and recovery functions.

## 2 Product execution standards

### 2.1 GB Standard

The design and production of DC/DC converters must comply with China's mandatory regulations and environmental regulations regarding vehicle requirements. The relevant national standards are as follows:

Table 1:

No.	Standard number	Standard Name	Remark
1	GB/T 24347-2009	Electric vehicle DC/DC converter	/
2	GB/T 18488.1-2015	Electric motors and their controllers for electric vehicles - Part 1: Technical specifications	/
3	GB/T 18384.2-2015	Safety requirements for electric vehicles - Part 2: Functional safety and fault protection	/
4	GB/T 18384.3-2015	Safety requirements for electric vehicles - Part 3: Personnel protection against electric shock	/
5	GB/T 18387-2008	Limits and measurement methods for electromagnetic field emission intensity of electric vehicles	/
6	GB/T 31498-2015	Safety requirements for electric vehicles after collision	/
7	GB 9254-2008	Radio disturbance limits and measurement methods for information technology equipment	/
8	GB/T 18655-2010	Limits and measurement methods for protecting onboard receivers using wireless disturbance characteristics of vehicles, ships, and internal combustion engines	/
9	GB 29743-2013	Motor vehicle engine coolant	/
10	GB 4208	Protection level of casing (IP code)	/
11	GB/T 28046-2	Environmental conditions and tests for electrical and electronic equipment of road vehicles - Part 2: Electrical loads	/
12	GB/T 28046-3	Environmental conditions and tests for electrical and electronic equipment of road vehicles - Part 3: Mechanical loads	/
13	GB/T 28046-4	Environmental conditions and tests for electrical and electronic equipment of road vehicles - Part 4: Climate loads	/
14	GB/T 2423.34-2012	Environmental Testing Part 2: Test Methods Test Z/AD: Temperature/Humidity Combined Cycle Test	/
15	GB/T 2423.1-2008	Environmental testing for electrical and electronic products - Part 1: Test methods - Test A: Low temperature	/
16	GB/T 2423.2-2008	Environmental testing for electrical and electronic products - Part 2: Test methods - Test B: High temperature	/
17	GB/T 2423.3-2016	Environmental testing for electrical and electronic products - Part 2: Test methods Cab: Constant humidity and heat test	/
18	GB/T 2423.17-2008	Environmental testing for electrical and electronic products - Part 2: Test methods - Test Ka: Salt spray	/
19	GB/T 30512-2014	Requirements for Prohibited Substances in Automobiles	/
20	QC/T 413	Basic Technical Conditions for Automotive Electrical Equipment	/

## 2.2 Foreign regulations

The target market includes models from foreign markets, which must comply with mandatory regulations and environmental regulations in the country and region where the target market is located.

Table 2:

No.	Standard number	Standard Name	Remark
1	CISPR 25: 2008	Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices – Limits and methods of measurement	/
2	ISO 7637-2:2011	Electrical disturbance from conduction and coupling Part 2 -Electrical transient conduction along supply lines only	/
3	ISO 7637-3:2007	Electrical disturbance from conduction and coupling Part 3-Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	/
4	ISO 11452-4:2005	Road Vehicles-Component test methods for electrical disturbances by narrow radiated electromagnetic energy-Part 4-Bulk current injection	/
5	ISO 10605:2008	Test methods for electrical disturbances from electrostatic discharge	/
6	ISO 16750-2:2012	Road Vehicles-Environmental conditions and testing for electrical and electronic equipment Part 2:Electrical load	/
7	ISO 16750-3:2012	Road Vehicles-Environmental conditions and testing for electrical and electronic equipment Part 3:Mechanical loads	/
8	ISO 16750-4:2010	Road vehicles-Environmental conditions and testing for electric and electronic equipment –Part 4:Climatic loads	/
9	ISO 16750-5:2010	Road vehicles-Environmental conditions and testing for electric and electronic equipment-Part 5:Chemical loads	/
10	ISO 6469-3:2011	Electrically propelled road vehicles-Safety specifications-Part 3:Protection of persons against electric shock	/
11	IEC 60068-2-6	Environmental testing-Part 2-6:TestFc:Vibration(Sinusoidal)	/
12	IEC 60068-2-14	Basic environmental testing procedures Part 2:Tests-Test N Change of temperature	/
13	IEC 60068-2-27	Environmental testing-Part 2-27:Tests test Ea and guidance: Shock	/
14	IEC 60068-2-32	Basic environmental testing procedures Part 2: Test-Test Ed Free fall	/
15	DIN 50018:1997	Sulfur dioxide corrosion testing in a saturated atmosphere	/
16	ISO 26262	Road vehicles — Functional safety	/
17	IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems	/
18	EN61000-4-2	Electromagnetic compatibility Part4:Testing and measurement techniques	/
19	LV148	48V-vehicleelectricalsystem	/

Note: Standards without specified version dates shall be executed according to their latest versions.

### 3 DC/DC converter specifications

#### 3.1 Usage specifications

Table 3:

Item	Description	Remark
Storage temperature	-40°C ~ 105°C	/
Working temperature	-40°C ~ 85°C	/
Humidity	5%~95%	Relative humidity
Cooling method	Natural cooling	/
Altitude	Normal use below 2000m, usage conditions provided above 2000m	/
Protection level	IP67	/
Resistance to vibration	<p>Sinusoidal Vibration Standard: EN/IEC 60068-2-6 (2009) Method: Frequency: 5-200Hz, sweep rate: 1x/min; Frequency/displacement: 5-18.6Hz 10mm; Frequency/acceleration: 18.6~50Hz 4.5g, 50~100Hz 4.5g, 100~200Hz 3g, vibration direction and time: work for 20 hours each in the vertical, horizontal left and right, and horizontal front and rear directions, working mode: Mode A, load outside the vibration bench, high and low voltage wiring harness connected to DC/DC, data recorded by the upper computer. Requirement: After the test, there should be no damage to the mechanical structure, deformation, or loosening of the fastening parts. After the test is completed, functional parameter testing should be conducted at room temperature, and all test items should meet the functional parameter requirements.</p> <p>Random Vibration Standard: ISO 16750-3 (2007) Method: Frequency range: 10-1000Hz, total root mean square acceleration: 27.8 m/s<sup>2</sup>; Energy Spectral Density 10Hz-20 (m/s<sup>2</sup>)<sup>2</sup>/Hz, 55Hz-6.5 (m/s<sup>2</sup>)<sup>2</sup>/Hz, 180Hz-0.25 (m/s<sup>2</sup>)<sup>2</sup>/Hz, 300Hz-0.25 (m/s<sup>2</sup>)<sup>2</sup>/Hz, 360Hz-0.14 (m/s<sup>2</sup>)<sup>2</sup>/Hz, 1000Hz-0.14 (m/s<sup>2</sup>)<sup>2</sup>/Hz, Vibration direction and time: 8 hours each in the vertical direction, horizontal left and right direction, and horizontal front and rear direction. Working mode: Mode A, the load is outside the vibration platform, the high and low voltage harnesses are connected to the</p>	Vibration conditions: pure electric passenger vehicles

	<p>DC/DC, and the upper computer records data</p> <p>Requirement: After the test, there should be no damage to the mechanical structure, deformation, or loosening of the fastening parts. After the test is completed, functional parameter testing should be conducted at room temperature, and all test items should meet the functional parameter requirements.</p>	
	<p>Mechanical shock</p> <p>Standard: EN/IEC 60068-2-27 (2009)</p> <p>Method: Pulse width: 11ms; Acceleration: 20g; Test direction and frequency:</p> <p>Vertical:+ Z10-Z10 times</p> <p>Horizontal left and right:+ Y10 times - Y10 times</p> <p>Before and after horizontal:+ X10 times - X10 times, the load is outside the vibration table, and the high and low voltage wiring harness is connected to the DC/DC connection mode: DC/DC does not power on</p> <p>Requirement: After the test, there should be no damage to the mechanical structure, deformation, or loosening of the fastening parts. After the test is completed, functional parameter testing should be conducted at room temperature, and all test items should meet the functional parameter requirements.</p>	
	<p>Drop Test</p> <p>Standard: EN/IEC 60068-2-32 (2009)</p> <p>Method: Drop direction: 6 faces, 8 corners</p> <p>Height: 500mm with packaging plan</p> <p>Requirement: After the test, the appearance of the DC/DC and the plug-in should be inspected according to the appearance requirements. After the test is completed, the functional parameters should be tested at room temperature, and all test items should meet the functional parameter requirements.</p>	
EMC	<p>RE, CISPR 25, level 2;</p> <p>CE, CISPR 25, level 2;</p> <p>RI, ISO11452-2, In the frequency range of 80M to 2000MHZ, the injection intensity is 75V/m;</p> <p>BCI, ISO11452-4, In the frequency range of 1MHZ to 400MHZ, the injection intensity is 75mA;</p> <p>ESD, ISO10605-2008,+/-8kV, 330 Ω/150pF, direct discharge test and indirect discharge test (see DVP for specific testing requirements)</p> <p>The transient immunity of the DC/DC power line meets the testing requirements of ISO7637-2 (see DVP for details on test pulses and functional levels);</p> <p>The transient coupling immunity on the DC/DC signal line meets the testing requirements of ISO7637-3.</p>	/

Noise	The working noise of the DC/DC converter shall not exceed 70dB	/
Grounding	The grounding resistance shall not exceed 0.1 $\Omega$ The grounding point should be clearly marked	/
Reliability	8 years/120000 km (calculated based on the service life of the capacitor)	/

## 3.2 Electrical specifications

### 3.2.1 48V to 12V DC/DC Electrical specifications

Table 4: 48V to 12V DC/DC Input Specifications

Item	Minimum	Nominal	Maximum	Remark
Input voltage range (V)	36	48	56	Normal battery voltage range: 36~56V Functional limit voltage range: 24~36V, 56~58V
Input current(A)		58		36V input, 2.0kW output
Standby current (mA) (Current consumed when the ignition switch is in the ON state)		300		Testing under 14V battery power supply

Table 5: 48V to 12V DC/DC Input Protection

Item	Protection point	Description	Remark
Input overvoltage	Overvoltage value: 56.1~60V Recovery value: 54-56V	Overvoltage value: 56.1~60V Recovery value: 54-56V	When the input voltage of the DC/DC exceeds the overvoltage protection value, the output should be turned off and an alarm should be triggered. After troubleshooting, it should have automatic recovery function.
Input undervoltage	Undervoltage value: 18~23V Recovery value: 23.1-26V	Undervoltage value: 18~23V Recovery value: 23.1-26V	When the DC/DC input voltage is less than the undervoltage protection value, the output should be turned off and an alarm should be triggered. After troubleshooting, it should have automatic recovery function.
Short circuit	Shut down; Fault resolved, self recoverable		

protection	
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Table 6: 48V to 12V DC/DC Output Specifications

Item	Nominal	Error	Description	Remark
Output voltage	14V		Adjustable range : 9-16V	The charging process is carried out according to the voltage and current instructions issued by the VCU
Output voltage accuracy	/	$\leq \pm 2\%$	/	/
Output Voltage Ripple	240mV	/	/	/
Output voltage monitoring accuracy	/	$\pm 0.3V$	/	/
Output current	142A	/	Adjustable range : 2-142A	The charging process is carried out according to the voltage and current instructions issued by the VCU
Output current monitoring accuracy	/	$\pm 1A$	/	/
Output power	2.0kW	/	/	Rated power $P_N$
Peak power and duration	2.4kW (170A)	/	1.2 $P_N$ within 6 minutes	Peak output power: 1.2 $P_N$ Duration: within 6min
Load Regulation	/	$\leq \pm 5\%$	/	/
Source adjustment rate	/	$\leq \pm 5\%$	/	/
Sleep current	$\leq 1mA$	/	/	/
Output response time	$\leq 200ms$	/	Input power on, time from receiving VCU enable command to establishing stable output voltage	The time for the output voltage to rise to stability
Overcharge	/	$\leq \pm 5\%$	/	on/off
Dynamic recovery time	$\leq 20ms$	/	Dynamic recovery time : $\leq 20ms$	Load dynamic range : 30%~80%~30%
Dynamic load effect	/	$\leq \pm 5\%$	Dynamic load effect : $\leq 5\%$	Load dynamic range : 30%~80%~30%
Shielding layer and casing resistance	$\leq 100m\Omega$	/		The casing of the DC/DC must be connected to the body grounding at an equipotential,

				and the contact resistance with the casing and body grounding components should be less than 0.1 Ω
Efficiency	≥94%	/		Rated input, rated output

Table 7: 48V to 12V DC/DC Output Protection

Item	Protection point	Description	Remark
Output overvoltage	Overvoltage value : 16.1V~18V Recovery value: >16V	Protection threshold 16.1~18V Recovery value: >16V	When the DC/DC output voltage exceeds the overvoltage protection value, the output should be turned off and an alarm should be triggered. After troubleshooting, it should have automatic recovery function.
Output undervoltage	Undervoltage value: 6V~9V Recovery value: <10V	Protection threshold 6V~9V Recovery value : <10V	When the DC/DC output voltage is less than the undervoltage protection value, the output should be turned off and an alarm prompt should be given After troubleshooting, it should have automatic recovery function.
Over Temperature Protection	Equipped with over temperature protection function, it allows power reduction operation at an ambient temperature of 55 °C~95 °C, and over temperature protection above 95 °C. When the temperature drops to a safe temperature (for example, the temperature at the detection point inside the DC/DC is less than 90 °C), it automatically resumes charging.		
Output overcurrent	Overcurrent protection: 175A~185A, shutdown, can be restored after the fault is resolved		
Short circuit protection	Before starting the DC/DC, if there is a short circuit in the output, it should not start after being powered on and an alarm should be triggered; During work, if there is a short circuit in the output, the output should be turned off and an alarm should be triggered. After troubleshooting, DC/DC should be able to work properly.		
Reverse polarity protection	When the positive and negative terminals of the DC/DC output are reversed, it should not start after being powered on. After troubleshooting, the DC/DC should be able to operate normally.		

### 3.2.2 12V to 48V DC/DCElectrical specifications (Reverse function)

Table 8: 12V to 48V DC/DC Input Specification

Item	Minimum	Nominal	Maximum	Remark
Input Voltage Range (V)	9	14	16	Normal battery voltage range

Input Current (A)		80		Input voltage is 9V, maximum load
Standby current (mA) (Current consumed when the ignition switch is in the ON state)		300		Test under 14V power supply
Rated input power (W)		500	750	Rated input, rated output

Table 9: 12V to 48V DC/DC Output Specification (Reverse function)

Item	Nominal	Error	Specification	Remark
Output voltage	48V	/	Adjustable range: 36~52V	The charging process is carried out according to the voltage and current instructions issued by the VCU
Output voltage accuracy	/	$\leq \pm 2\%$	/	/
Output Voltage Ripple	480mV	/	/	/
Accuracy of output voltage monitoring	/	$\pm 2V$	/	/
Output current	10A	/	Adjustable range: 1~10A	The charging process is carried out according to the voltage and current instructions issued by the VCU
Output current monitoring accuracy	/	$\pm 0.5A$	/	/
Output power	0.5kW	/	/	/
Load Regulation	/	$\leq \pm 1\%$	/	/
Source adjustment rate	/	$\leq \pm 1\%$	/	/
Sleep current	$\leq 1mA$	/	/	/
Output response time	$\leq 200ms$	/	/	The output voltage rises to stability
Output overcharge	/	$\leq \pm 5\%$	/	on/off
Output response time	$\leq 200ms$	/	/	Input power on, from receiving VCU enable command to establishing stable output voltage
Dynamic recovery time	$\leq 20ms$	/	Dynamic recovery time : $\leq 20ms$	Load dynamic range: 30%~80%~30%
Dynamic load effect	/	$\leq \pm 5\%$	Dynamic load effect: $\leq 5\%$	Load dynamic range: 30%~80%~30%
Efficiency	$\geq 93\%$	/	/	Rated input, full load output

Table 10: 12V to 48V DC/DC Input protection (reverse function)

Item	Protection point	Description	Remark
Input overvoltage	Overvoltage value : 18~20V Recovery value: >16V	Protection threshold 18 ~ 20V Recovery value: >16V	When the input voltage of the DC/DC exceeds the overvoltage protection value, the output should be turned off and an alarm should be triggered. After troubleshooting, it should have automatic recovery function.
Input undervoltage	Undervoltage value : 6V~9V Recovery value: >10V	Protection threshold 6~9V Recovery value: >10V	When the DC/DC input voltage is less than the undervoltage protection value, the output should be turned off and an alarm prompt should be given. After troubleshooting, it should have automatic recovery function.
Short circuit protection	Shut down; Fault resolved, self recoverable		

Table 11: 12V 转 48V DC/DC Output Protection

Item	Protection point	Description	Remark
Output overvoltage	Overvoltage value : 54~58V Recovery value : <54V	Protection threshold 54~58V, Recovery value: <54V	When the DC/DC output voltage exceeds the overvoltage protection value, the output should be turned off and an alarm should be triggered. After troubleshooting, it should have automatic recovery function.
Output undervoltage	Undervoltage value: 20~24V Recovery value: >26V	Protection threshold 20V~24V, Recovery value: >26V	When the DC/DC output voltage is less than the undervoltage protection value, the output should be turned off and an alarm prompt should be given. After troubleshooting, it should have automatic recovery function.
Over Temperature Protection	Equipped with over temperature protection function, it can operate at full load at room temperature, allowing power reduction operation at an ambient temperature of 55 °C~95 °C, and over temperature protection above 95 °C. When the temperature drops to a safe temperature (for example, the temperature of the detection temperature point inside the DC/DC is less than 90 °C), it will automatically resume charging.		

Output overcurrent	13A~18A, shutdown, can be restored after the fault is resolved
Short circuit protection	Before starting the DC/DC, if there is a short circuit in the output, it should not start after being powered on and an alarm should be triggered; During work, if there is a short circuit in the output, the output should be turned off and an alarm should be triggered. After troubleshooting, DC/DC should be able to work normally
Battery reverse connection protection	When the positive and negative terminals of the output are reversed, it should not start after being powered on. After troubleshooting, the DC/DC should be able to work normally

### 3.3 Control logic

- 1、 Low voltage KL30 long-term power supply (9-16V-DC/DC can work normally, 6-16V ensures normal CAN communication);
- 2、 After the key signal KL15 reaches a high level (6-16V), KL30 supplies power to the auxiliary power supply through the DC/DC internal switch;
- 3、 DC/DC\_Snable enable mode: CAN;
- 4、 DC/DC Disable shutdown control:
  - a、 Through CAN communication method
  - b、 DC/DC detects that the hardware wake-up signal jumps from high level to low level, and detects that the low level lasts for 1 second

### 3.4 CAN Network System

**Equipped with CAN wake-up function and using standard CAN2.0B communication protocol.**

### 3.5 DC/DC System functional requirements

Supports CANBUSOFF function and UDS refresh. CAN enable function.

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## 4. Interface requirements

### 4.1 Electrical pin

Table 13: Pins Definition

Pin	Definition	Remark
PIN1	/	/
PIN2	KL30	12V auxiliary power supply, connected to 12V battery
PIN3	/	/
PIN4	A_CAN_L	CAN L
PIN5	A_CAN_H	CAN H
PIN6	KL15	Key signal, hardware wake-up, 12V high level effective, high level duration greater than 100ms
PIN7	/	/
PIN8	/	/
PIN9	/	/
PIN10	/	/

### 4.2 software interface

Table 14: Apply CAN signal

Item	作用 Usage	协议 Protocol
CAN	通讯 Communication	CAN2.0B, baud rate 250KB/s

## 5 Mechanical and appearance requirements

### 5.1 Size and weight (including connector terminals)

Table 15:

Item	Nominal value	Error
Height	60mm	<±1 mm
Width	219mm	<±1 mm
Length	250mm	<±1 mm
Weight	< 3.0kg	For reference only, subject to the final prototype (2.72KG)

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## 5.2 Outline dimension diagram



